

# Chemical Vapor Deposition

*Imagination is the limit for chemical vapor deposition coatings*

**C**hemical vapor deposition (CVD) is a technique to deposit a solid coating on a heated substrate directly from the gas phase. The coating material is usually deposited by either thermal decomposition of complex precursor chemicals or hydrogen reduction of precursor gases that contain the desired elements.

CVD coatings have many advantages and uses, including:

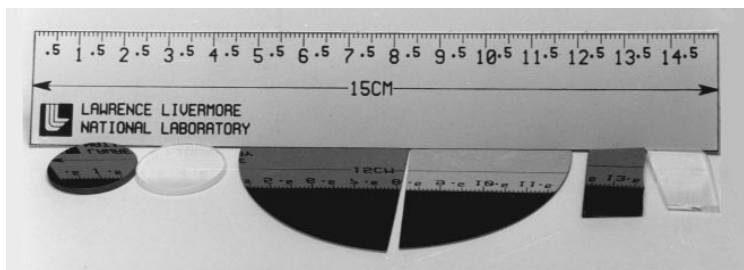
- Wear and oxidation resistance
- Corrosion protection (from liquid metals)
- Friction reduction
- Biological compatibility
- Controlled reflectivity for optics
- Decoration.

## CVD reactors used to produce diamond surfaces and tubes made from coatings

LLNL operates three hot- and cold-wall CVD reactors at atmospheric to low pressures. The largest has a usable hot zone 50 cm in diameter by 75 cm long, with a maximum temperature of

1100°C. The small induction-heated, cold-wall reactor can reach substrate temperatures higher than 1500°C. Plasma techniques or DC biasing allow lower deposition temperatures and improved adhesion for many materials.

We have deposited a wide range of materials, including refractory metals and alloys, carbides, borides, nitrides, oxides, and diamond and



Anti-reflective, CVD-coated forms appear white. The corresponding uncoated forms show numbers reflected from the scale.

diamond-like carbon. For example, diamond crystals were made using hot-filament decomposition of  $\text{CH}_4$ . The tungsten filament is heated to 1800°C at reduced pressure, and the diamond is deposited on a molybdenum substrate held at 1000°C. Microwave plasma techniques can also be used to form diamond coatings. Another example is tungsten-rhenium tubing that has significant ductility at room temperature and good mechanical properties up to 1800°C. A tungsten-rhenium coating of the desired thickness is deposited on a molybdenum tube substrate. The substrate is then chemically etched away to leave a free-standing tube. The initial surface of the tube is rough, but centerless grinding gives it an excellent surface finish.

**Availability:** Our current interests include deposition of Group IV and V metal nitrides, mixed metal nitrides, oxides, and refractory metals.

## Contact

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## APPLICATIONS

- Coating cemented tungsten carbide tool inserts with TiN, TiC, or  $\text{Al}_2\text{O}_3$
- Forming thick nickel shapes by decomposition of  $\text{Ni}(\text{CO})_6$
- Fabricating microelectronic circuits
- Manufacturing components for solid oxide fuel cells